

Claims

- [c1] 1.A SOFC system including a fuel cell having a fuel intake, an air intake, a cathode exhaust and an anode exhaust, and comprising an integrated module comprising an afterburner, a fuel processor and a heat exchanger, wherein:
- (a)said afterburner comprises an intake connected to the anode exhaust, or anode and cathode exhausts, and an igniter;
- (b)said heat exchanger comprises an intake connected to an air supply and an exhaust connected to the air intake of the SOFC wherein the heat exchanger is thermally coupled to the afterburner; and
- (c)said fuel processor comprises an intake connected to a fuel/water supply, a fuel reforming catalyst, and an exhaust connected to the fuel intake of the SOFC wherein the fuel processor is thermally coupled to the heat exchanger and/or the afterburner.
- [c2] 2.The SOFC system of claim 1 wherein the module comprises three concentric stages, wherein the afterburner comprises a central elongate, substantially cylindrical tube, the heat exchanger surrounds the afterburner, and the fuel processor surrounds the heat exchanger.
- [c3] 3.The SOFC system of claim 2 further comprising a baffle within the heat exchanger for routing air along an indirect path from the heat exchanger intake to the heat exchanger exhaust.
- [c4] 4.The SOFC system of claim 3 wherein said baffle comprises an inclined plane which encircles the afterburner.
- [c5] 5.The SOFC system of claim 2 further comprising heat fins projecting from the heat exchanger into the fuel processor.
- [c6] 6.The SOFC system of claim 1 further comprising a low temperature heat exchanger which accepts the exhaust of the afterburner to preheat air and/or fuel/water entering the integrated module.
- [c7] 7.An integrated module for use with a SOFC having an intake fuel/water stream, an intake air stream, a cathode exhaust stream and an anode exhaust stream,

said module comprising:

- (a) an inlet for accepting the anode exhaust stream or anode and cathode exhaust streams from the SOFC;
- (b) a combustion chamber in fluid communication with the exhaust stream inlet comprising an igniter and an exhaust;
- (c) a heat exchanger associated with the combustion chamber for transferring heat from the combustion chamber to the intake air stream of the SOFC; and
- (d) a fuel processor associated with the combustion chamber and/or heat exchanger comprising a reforming catalyst wherein the intake fuel stream is first combined with water or steam then heated and passed over the catalyst within the fuel processor to enrich the fuel in hydrogen prior to entering the SOFC.

[c8]

8. The integrated module of claim 7 wherein the combustion chamber is an elongate cylinder and the heat exchanger concentrically encircles the combustion chamber.

[c9]

9. The integrated module of claim 8 wherein the fuel processor concentrically encircles the heat exchanger.

[c10]

10. The integrated module of claim 9 wherein the fuel processor comprises a plurality of heat fins projecting from the heat exchanger into the fuel processor and a perforated baffle block for retaining the catalyst while permitting fluid flow through the fuel processor.

[c11]

11. A method of extracting energy from the exhaust of a SOFC comprising the steps of :

- (a) burning unused fuel from the exhaust stream to produce heat;
- (b) using the heat produced in step (a) to preheat the intake air streams into the SOFC; and
- (c) using the heat produced in step (a) to heat the intake fuel stream in the presence of a reforming catalyst and steam to enrich the fuel stream with hydrogen.

- [c12] 12.The method of claim 11 wherein the method is implemented in an integrated module comprising an afterburner for implementing step (a), a heat exchanger for implementing step (b) and a fuel processor for implementing step (c).
- [c13] 13.The method of claim 12 wherein the integrated module comprises a cylindrical afterburner, heat exchanger and fuel processor, wherein the heat exchanger concentrically encircles the afterburner and the fuel processor concentrically encircles the heat exchanger.
- [c14] 14.The method of claim 11 wherein the afterburner receives exhaust from both cathode and anode exhausts of the SOFC.
- [c15] 15.A SOFC system including a fuel cell having a fuel intake, an air intake, a cathode exhaust and an anode exhaust, and comprising an integrated module comprising an afterburner, a fuel processor and a heat exchanger, wherein:
(a)said afterburner comprises a central elongate, substantially cylindrical tube, an intake at one end of the tube connected to the anode exhaust and cathode exhaust and an igniter;
(b)said heat exchanger surrounds the afterburner and comprises an intake connected to an air supply and an exhaust connected to the air intake of the SOFC; and
(c)said fuel processor surrounds the heat exchanger and comprises an intake connected to a fuel supply/water, a fuel reforming catalyst, and an exhaust connected to the fuel intake of the SOFC.